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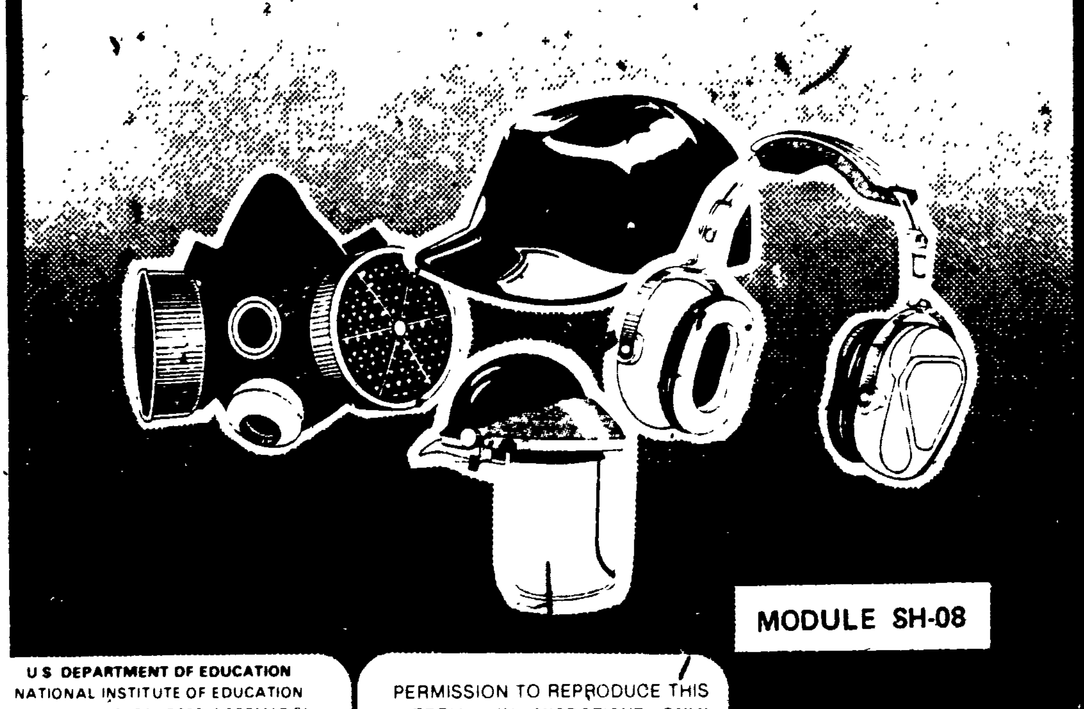
ABSTRACT

This student module on recognizing job health hazards is one of 50 modules concerned with job safety and health. This module presents the four general categories of environmental conditions or stresses: chemical, physical, biological, and ergonomic. Following the introduction, 14 objectives (each keyed to a page in the text) the student is expected to accomplish are listed (e.g., Identify four biological health hazards). Then each objective is taught in detail, sometimes accompanied by illustrations. Learning activities are included. A list of references and answers to learning activities complete the module. (CT)

SAFETY AND HEALTH

RECOGNIZING JOB HEALTH HAZARDS



MODULE SH-08

CORD CENTER FOR OCCUPATIONAL RESEARCH AND DEVELOPMENT

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INTRODUCTION

We live in an age of complex manufacturing processes. As our society becomes more sophisticated, workers and employers alike desire more complete information about the materials with which they work. A greater understanding of the hazards associated with the use of certain chemicals, high energy forms, biological agents and mechanical processes is the first step in creating healthier work environments.

Job health hazards are those environmental conditions or stresses that may have adverse effects on health, that may be uncomfortable or irritating, or that may have some undesired effect upon the ability of an individual to perform the required work.

This module presents the four general categories of environmental conditions or stresses: chemical, physical, biological, or ergonomic. These are discussed in relation to methods of entry into the body, sources of contamination, and methods of protection. Finally, a list is given of observable conditions that could indicate the presence of a health hazard in the workplace.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. Outline the process of recognition, evaluation, and control of job-related health hazards. (Page 3)
2. State the four categories of health hazards and give examples of each. (Page 6)
3. Describe the routes of entry and the way they interact with contamination in the environment. (Page 8)
4. Define TLV and PEL. (Page 14)
5. Define six physical states in which chemical contaminants may be present in the air. (Page 15)
6. Name two hazardous dusts and give an example of a disease associated with each hazard. (Page 17)

7. Outline two different ways of classifying respiratory irritants. (Page 20)
8. Briefly explain asphyxiants, anesthetics, systemic poisons and agents of dermatitis. (Page 22)
9. Cite five types of physical health hazards. (Page 25)
10. Identify health hazards associated with different types of radiation. ~~(Page~~ 28)
11. Identify four biological health hazards. (Page 31)
12. Name and describe three ergonomic health hazards. (Page 33)
13. List the personal and mechanical protective mechanisms used to avoid health hazards. (Page 35)
14. List ten observable conditions that could indicate the presence of a health hazard on the job. (Page 38)

OBJECTIVE 1: Outline the process of recognition, evaluation, and control of job-related health hazards.

Effective dealing with possible job-related health hazards actually includes three basic activities. These activities are (1) recognition of the potential hazard, (2) evaluation of the hazard to determine the relative degree of danger, if any, and (3) control of the hazard.

The science devoted to the recognition, evaluation, and control of environmental health hazards is called industrial hygiene. An industrial hygienist is often the person who examines the work environment to determine what health hazards may be present and what measures are necessary to deal with them. The industrial hygienist may choose the methods of examination (the instruments to be used or the number of tests to be run) and supervise the work of technicians who carry them out.

Recognition is the first step to correcting potential health hazards. Individuals apply this step when using their senses of sight, smell, hearing, touch, and taste. By looking at the atmosphere, a person can sometimes see vapors or dusts in the air, or the discoloration of a wall or ceiling. These are two conditions that may indicate a hazard. Similarly, the sense of smell sometimes alerts people to odors that may indicate a fire or to the smell of a chemical that may be harmful. The sense of hearing may alert a person to escaping gas, or the sound of a horn may be used to warn people of the release of harmful substances into the atmosphere.

However, human senses are limited in their ability to detect job-related health hazards. (See Figure 1.) The classic example of this limitation is carbon monoxide, a colorless, odorless, tasteless gas that is not recognizable through any of the human senses. Another example of how the senses are poor indicators of health hazards is hydrogen sulfide. Hydrogen sulfide smells like rotten eggs, the odor of which is repulsive to most people. However, the sense of smell quickly becomes anesthetized by the hydrogen sulfide and at that point, the presence of the chemical is no longer perceived. Since hydrogen sulfide can become deadly in a few breaths if enough of it is present in the air, a more reliable indicator than the nose must be used to alert people to its presence.

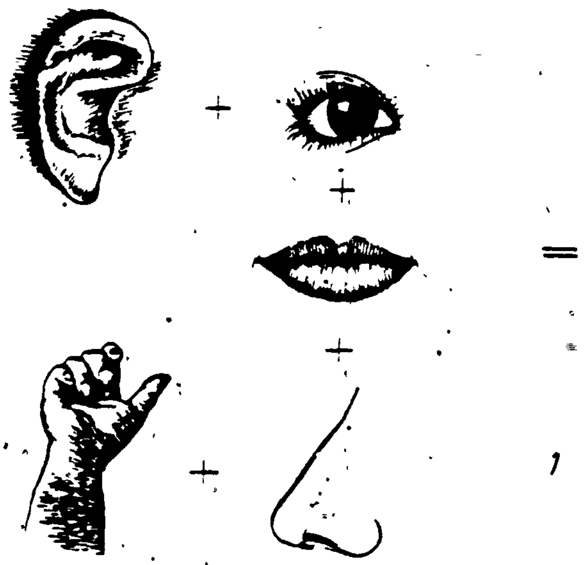

Figure 1. Some hazards cannot be detected by the unaided human senses.

The sense of hearing is used to determine whether a sound is loud, but it is only a relative indicator of loudness. A person's hearing mechanism may be damaged when it is exposed to loud noise. Once damaged by noise, hearing usually cannot be repaired, deafness progresses, and loud noise no longer sounds loud. The loss of hearing due to noise may occur not only from industrial noise but also from loud music, hobbies that require the operation of power equipment, and sports that involve shooting.

Despite their drawbacks, the human senses may be useful at times in the recognition of job-related health hazards. To compensate for the limitations of the senses, instrumentation has been developed to assist in the recognition of job-related health hazards. Some of the instruments are rather complicated and require highly trained operators; others are less complex and require less training for their operation.

Once a potential hazard has been recognized, the degree of hazard needs to be understood. Evaluation procedures help determine the degree of hazard presented by a substance. Obviously, all things do not present the same degree of hazard. By determining the amount of a chemical in the air or the amount of noise in an area, the degree of danger can be found. This is accomplished with the use of instruments specifically designed to give a numerical value (quantification) to the substance, chemical, or force that presents a problem.

Control of job health hazards may be achieved through nine different types of action. The method of control selected must be appropriate to the hazard. Often more than one of these methods may be chosen:

- Substitution of a less harmful material for one which is dangerous to health, such as using a detergent and water cleaning solution in place of organic solvents wherever it is possible to do so.
- Change or alteration of an industrial process to minimize worker contact with the hazard. For example, brush-painting rather than spray painting will reduce the concentration of airborne contaminants (harmful substances) from toxic pigments.
- Isolation or enclosure of a process or work operation to reduce the number of persons exposed. This is done by using a physical barrier such as sound-absorbing screens to reduce machinery noise, or by increasing the distance between workers and the source of the noise.
- The use of water sprays to reduce dust hazards (this is useful where vacuum cleaning cannot be applied).
- General or dilution ventilation with clean air to provide a safe atmosphere. When air is added to the ventilation system, the concentration of a contaminant can be kept below hazardous levels.
- Local exhaust ventilation systems, which use booths, hoods and other equipment to remove a contaminant at its source.
- Personal protective equipment which may be worn by workers if other controls cannot eliminate a hazard or reduce it sufficiently. Personal protective equipment includes helmets, steel-toed shoes, gloves, respirators, goggles, shields, earmuffs, and other protective clothing and equipment.
- Good housekeeping practices that affect the cleanliness of the workplace. These practices include waste disposal, adequate washing, toilet and eating facilities, healthful drinking water, and control of insects and rodents.
- Training and education in procedures that make engineering controls effective, such as knowing when and how to activate a local exhaust system.

The final step in dealing effectively with job health hazards is to choose and implement control measures. The efforts involved in recognizing and evaluating a potential hazard will be wasted if the last step is not carried out.

ACTIVITY 1:*

Match the items listed below on the right with the corresponding heading on the left.

___ 1. Recognition	a.	People working in a metal salvage plant are trained in the use of filter respirators.
___ 2. Evaluation	b.	An industrial hygienist collects air samples in a textile factory so that the amount of cotton dust in the air may be determined.
___ 3. Control	c.	An office worker smells smoke from a fire in the copying room.

OBJECTIVE 2: State the four categories of health hazards and give examples of each.

Health hazards that are encountered in the workplace cover a whole range of disorders involving many parts of the body, including lungs, liver, blood, kidney, skin, eyes, ears, brain, and nervous system. Frequently these hazards escape detection; they can be misdiagnosed by a physician, since they do not come with a label. Further, individuals are affected very differently by environmental hazards. Some exposures to hazards result in immediate effects, or in effects that develop within a short period of time (carbon monoxide or food poisoning). Other exposures produce effects that appear long after initial exposure (mercury, noise, or radiation). New

*Answers to Activities appear on page 41.

substances, new proceses, and new uses for old materials are continually appearing in industry, along with new potential hazards. Health hazards are complex to recognize and understand because of all these factors.

In learning to recognize on-the-job health hazards, workers may find it helpful to think in terms of four main categories of health hazards: chemical, physical, biological and ergonomic.

Chemical health hazards are usually encountered by workers in the form of air contaminants or skin irritants. Air contaminants, which may be in the form of gases, dust, fumes, mists or vapors, are breathed in by workers and affect the internal organs of the body. Skin irritants affect the surface of the body. Under some circumstances chemicals may be ingested.

Physical health hazards include radiation, noise, vibration, temperature and pressure. The effects of some of these physical hazards are often subtle and, unless the worker is alert to the possible dangers, can be overlooked.

Biological hazards include rodents, molds, fungi, viruses, parasites, and bacteria. Some of these hazards can be controlled by general and personal cleanliness; others require professional attention.

Ergonomic health hazards arise from the poor design of equipment, or from work operations which are set up so that the worker becomes easily bored and fatigued. With well designed equipment and good planning of the work situation, ergonomic hazards can be reduced or eliminated.

ACTIVITY 2:

1. List the four categories of health hazards.
   a. ______
   b. ______
   c. ______
   d. ______
2. Give two examples of each type of hazard.
   a. ______, ______
   b. ______, ______
   c. ______, ______
   d. ______, ______

OBJECTIVE 3: Describe the routes of entry and the way they interact with contamination in the environment.

In the industrial work situation there are three major ways for toxic substances to enter the human body. These routes of entry are inhalation, absorption, and ingestion.

Inhalation hazards arise from excessive concentrations (amounts) of mists, vapors, gases, or solids that are in the form of dusts or fumes. These hazards enter the body through the respiratory system. The respiratory system brings air containing oxygen into the lungs, where oxygen transfers to the blood and carbon dioxide transfers from the blood to the lungs and is then breathed out of the system. Air travels through the nasal passages, trachea, and bronchial tubes where some particles are filtered by the nasal hairs and trapped by mucus. The bronchi branching from the trachea divide into smaller and smaller bronchioles, which end eventually in clusters of air sacs, known as alveoli. (Figure 2.)

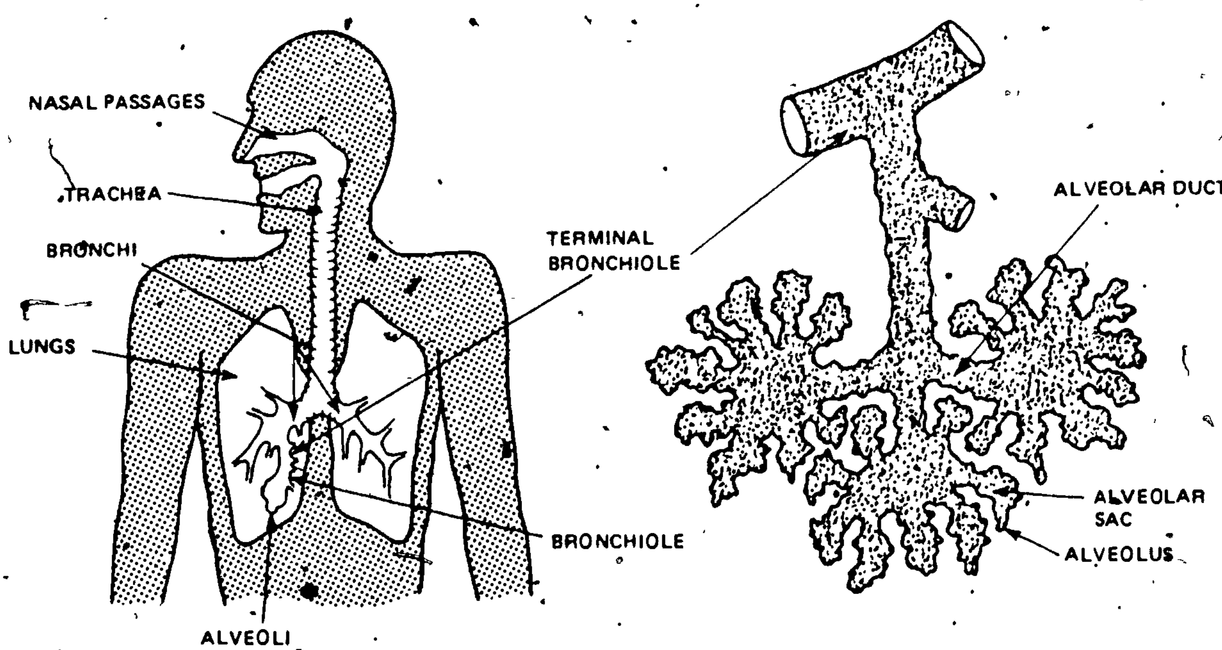

Figure 2. The lung.

The lung does its job of taking in oxygen from the air and transferring it through the blood stream to the cells very efficiently. This efficiency also allows the lung to easily take in other gases and vapors and transport them by the same route. The alveoli, where gas exchange takes place, is comprised of a surface area of approximately 70 square meters. The total lung surface area approaches 100 square meters. The surface area of a tennis court approximates the surface area of the lung. By visualizing this comparison, one can readily grasp how easily a contaminant might be able to enter the body through inhalation.

The opportunity for overexposure to a toxic substance is not limited to the size of the lung's surface area alone. It may also be affected by how rapidly or deeply the person breathes. The amount of air entering the lung may vary from one-half to over one and one-quarter cubic meters of air per hour. With such a large volume of air passing through the lungs in a day, only a relatively small amount of contaminants may have to be inhaled to be harmful. The two factors, lung surface area and volume of air passing through the lung, combined with the direct route from the lung through the blood stream to the cells, clearly show the importance of protecting workers from inhaling certain substances.

Airborne contaminants must become "airborne" before they pose a threat. This statement may seem simple, but is basic to preventing opportunities for inhalation of toxic substances. When an operation, such as degreasing, which cleans oil and grime from metal parts, is done at too high a temperature, vapors are driven off and into the breathing zone of the worker. Another example that occurs all too often in industry is the blowing of dust off a bench or work area, again forcing the dust into the breathing zone of the worker. The proper method of dust removal would be to use a vacuum cleaner to reduce the spread of the dust. Ventilation systems work in a similar fashion to draw dust from the breathing zone of operations such as grinding.

Other methods of controlling respiratory hazards include isolating the manufacturing process, substituting less harmful substances where possible, wearing of respirators that filter out dusts or actually supply clean air for breathing, and following good housekeeping practices.

Skin absorption of chemicals is the second route of entry into the body for chemical substances. Some substances are absorbed by way of openings for hair follicles; others dissolve in the fats and oils of the skin. Of all occupational diseases, skin ailments are the most frequent. Perhaps one reason for this widespread occurrence of skin disease is that the skin surface area is almost always available for potential contact with a harmful chemical or irritant. Dermatosis is the name given to any disease of the skin; dermatitis refers to any inflammation of the skin. However, the danger of skin exposure is not limited to the skin surface alone. Some chemicals can penetrate the skin, enter the blood stream, and then harm other body systems.

Skin plays a part in holding the body together, in regulating body temperature, in protecting body organs, and in protecting the whole body against physical harm. However, the skin is not a solid barrier to penetration by outside irritants. Some chemicals such as phenol and hydrogen cyanide can penetrate the skin and harm the internal body organs. The skin is a complex selective filter which protects against some chemicals while it allows others to penetrate into the body. The skin is composed of two layers called the epidermis, or outer layer, and the dermis, which allows the skin to have its resiliency. (See Figure 3.)

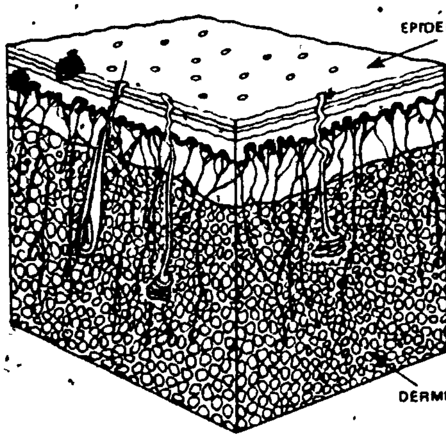

Figure 3. The skin has two layers.

The skin reacts to a toxic substance in one of several ways: the skin may block the substance from penetrating into the body; the skin surface may be injured; or the toxic substance may be allowed to enter the bloodstream and harm other body organs. A cut will enable a toxic substance to penetrate the skin's selective barrier and enter the body directly.

Chemical substances are not the only cause of occupational dermatosis and dermatitis. Mechanical agents such as friction, vibration, and pressure can cause blisters and calluses to form. Physical agents such as heat, cold, sunlight, and ionizing radiation can harm the skin. Certain plants cause dermatitis, and biological agents including parasites, bacteria, and fungi can also cause skin irritation and disease.

How can dermatitis be prevented? The most obvious way is to prevent skin contact with the toxic substances. This can be accomplished by designing a work operation to ensure the skin does not touch the substance, by enclosing the process, or by providing proper ventilation for the process. The manner in which solvents such as naptha, gasoline, or alcohol are used can pose a real threat to skin. Splashing of solvents onto the skin while pouring them from one container to another or when agitating an open container must be carefully avoided. Careful work practices are absolutely necessary to ensure protection of the skin.

Another method of prevention is to wear personal protective equipment such as proper rubber gloves, aprons, coveralls, and boots. This will help keep the toxic substance from touching the skin. Even the wearing of protective equipment does not guarantee complete protection. Proper selection and maintenance are important if protective clothing or equipment is to function as planned. If the gloves or the personal protective clothing are not the correct type or are not properly washed and dried before use, solvents may come into contact with the skin, creating severe skin irritation. It is wrong to assume that all "rubber" gloves, boots, or coveralls are the same. Solvent permeability (the extent to which solvents can penetrate a material) must be considered in the selection of gloves and other protective apparel. Finally, to be effective, personal protective equipment must be accepted by the worker and <u>worn</u>.

Once the skin has come in contact with a toxic substance, the best and perhaps the simplest solution to preventing skin irritation is washing with soap and water. (See Figure 4.) Eye-wash fountains and rapid-action safety showers are required when contact with acid occurs.

Another method of exposure to toxic substance is ingestion through the mouth and digestive system. Dust from toxic substances may be ingested while an employee is eating, smoking or applying lipstick or chapstick. The fact that a toxic substance has been swallowed does not necessarily mean that it will be absorbed or cause harm to the individual. Food and liquid in the digestive tract may dilute the toxic effect of the substance. The toxic substance may not be soluble in the digestive system and can be eliminated through the normal digestive processes. In addition, some of the toxic substance may be detoxified by the liver if it enters the blood system and the amount of toxic substance is not too great. The effectiveness of the digestive system's dilution or detoxification depends upon the toxicity of the substance and its concentration.

Often a toxic substance is ingested when food has been left in the workplace. Leaving food where a process is taking place, such as behind a machine or under a work bench, can allow toxic dusts or liquids to get on it. When the food is eaten, the toxic substance is also ingested. When persons who contact toxic substances in the work area do not wash their hands and face before eating lunch or getting a snack, ingestion can occur. Toxic substances can also be ingested when cigarettes have been exposed to a toxic dust, liquid, or vapor. Cigarettes can absorb vapors into the tobacco even while in a worker's pocket and later, when they are smoked, the individual inhales as well as ingests the toxic substance. (Figure 5.)

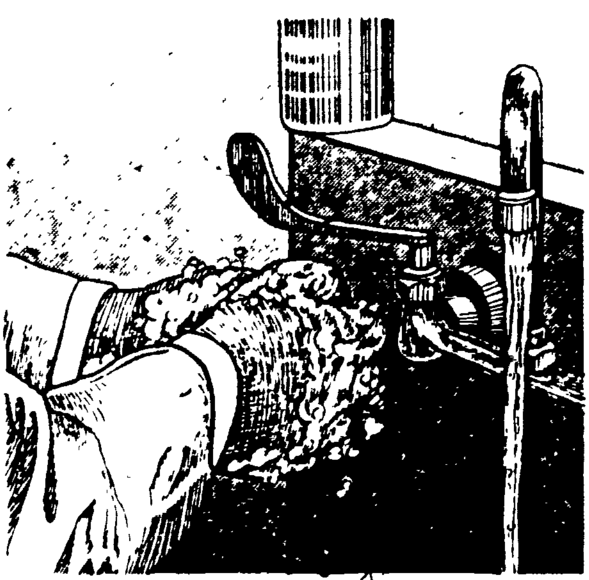

Figure 4. The simplest solution for preventing skin irritation may be washing the skin with soap and water.

Figure 5. Cigarettes can absorb toxic vapors into the tobacco.

When determining the possibility of an exposure to a toxic substance, consideration must be given to the raw product or chemical in the process, as well as to its manufactured by-products. Very few chemical reactions or processes complete their work without producing some form of by-product. An understanding of the process is necessary to properly evaluate and control the hazards that may present themselves in the product or its by-product.

ACTIVITY 3:

1. Name the three ways that toxic substances enter the body.
   a. ______________________
   b. ______________________
   c. ______________________
2. (Fill in the blanks.)
   a. ____________ hazards arise from excessive concentrations of mists, vapors, gases, or solids in the form of dust or fumes.
   b. Lung surface and area and ____________ of air passing through the ____________, combined with the direct route from the lung through the ____________ to the cells, are the factors that make the body susceptible to these hazards.
   c. Skin is a selective ____________ that allows some chemicals to penetrate while stopping others.
   d. Solvents such as naptha, ____________, or ____________ can cause skin penetration or dermatitis.
3. (Circle True or False.)

   True False a. Cigarettes can absorb vapors while in a worker's pocket.

True False b. Personal protective equipment guarantees complete protection from splashing hazards.

OBJECTIVE 4: Define TLV and PEL.

A Threshold Limit Value (TLV) refers to airborne concentrations of substances. A TLV represents an exposure level under which most people can work, day after day, without experiencing ill effects upon their health. Since individuals differ widely in their susceptibility to different substances, threshold limit values are not absolute. Occasionally, exposure of an individual to concentrations of airborne contaminants at or below the TLV may result in discomfort or illness.

The term TLV refers specifically to limits published by the American Conference of Governmental Industrial Hygienists. These TLV limits are reviewed and updated each year. There are three categories of Theshold Limit Values:

- Time-Weighted Average (TLV-TWA) is the average concentration considered safe for a normal eight-hour day or forty-hour week.
- Short-term Exposure Limit (TLV-STEL) is the maximal concentration to which persons can be exposed continuously for a period of up to fifteen minutes, without suffering irritation or chronic (long-term) or irreversible change in body tissues. Any dizziness, stupor, or tendency to lose consciousness that would increase the probability of accident or reduce work efficiency would also be cause for setting a Short-term Exposure Limit.
- Ceiling (TLV-C) is the concentration that should not be exceeded even for an instant.

As mentioned previously, threshold limit values are not absolute. Concentrations of chemicals rarely remain constant in the workplace throughout the day. Further, most work environments contain mixtures of chemicals rather than a single compound. Finally, all individuals are not going to react to the same substance in the same way.

The first compilation of health and safety standards from the U.S. Department of Labor's OSHA (Occupational Safety and Health Administration) appeared in 1970. Because it was derived from then-existing standards, it adopted many of the TLVs established in 1968 by the American Conference of Governmental Industrial Hygienists.

Thus, Threshold Limit Values - a copyrighted trademark of the American Conference of Industrial Hygienists - became, by Federal Standards, Permissible Exposure Limits (PELs). These PELs represent the maximum level of contaminants allowed in the air of the workplace.

ACTIVITY 4:

1. (Fill in the blanks.)
   a. TLV means ______________ ______________ ______________.
   b. PEL means ______________ ______________ ______________.
2. a. Time-weighted average is the average ________ of an airborne substance considered ________ for a normal eight-hour day or forty-hour week.
3. (Circle True or False.)

True	False	a. The concentrations of chemicals in the workplace usually remain constant throughout the day.
True	False	b. Individuals differ widely in their susceptibility to different substances.
True	False	c. Ceiling (TLV-C) is a concentration that can be safely exceeded for short time periods.

OBJECTIVE 5: Define six physical states in which chemical contaminants may be present in the air.

Chemical health hazards are usually in the form of air contaminants and skin irritants. The air contaminants are inhaled and affect the internal organs of the body such as the lung, blood-forming system, liver, and kidney. The skin irritants affect the surface of the body by causing rashes, blisters, and skin changes.

Chemicals exist in various physical states, and each has a specific definition:

Liquid - a state of matter in which the substance is a formless fluid that flows, having contant volume but not shape.

Gas - a state of matter in which the substance has neither a definite volume or shape. It can be changed to a liquid or a solid state by the combined effect of increased temperature and decreased pressure.

Dust - solid particles generated by grinding, crushing, impact detonation, or other forms of energy resulting in the physical breaking down of organic or inorganic materials such as rock, metal, coal, wood, and grain. Dusts do not tend to mass together except under electrostatic forces. They do not diffuse in the air but settle under the influence of gravity.

Fume - solid particles (less than one micrometer in diameter) generated by condensation from the gaseous state. Fumes tend to mass together and form chains or clumps.

Mist - suspended liquid droplets generated by condensation from the gaseous to the liquid state as by atomizing, foaming, or splashing.

Vapor - the gaseous form of a substance which is normally in the liquid or solid state and which can be transferred to these states either by increasing the pressure or decreasing the temperature.

When discussing these types of chemical health hazards, it is important to understand the meaning of each term.

ACTIVITY 5:

1. List six different physical states of chemical contaminants.

   a. ________ d. ________

   b. ________ e. ________

   c. ________ f. ________

2. State the difference between a gas and a vapor.

   ____

   ____

3. Define dust. ____

____

OBJECTIVE 6: Name two hazardous dusts and give an example of a disease associated with each hazard.

Dusts and other particles are always found in the air in varying amounts. However, these particles can overwhelm the human defense mechanisms, presenting potential health hazards on these three levels:

- The inhalation of sufficient quantities of dust can cause a person to choke or cough, regardless of the chemical composition of the dust.
- Depending upon its chemical composition, the dust can cause allergic or sensitization reaction in the respiratory tract or on the skin.
- Depending upon both the size of the particles and the chemical composition the dust can damage vital internal tissues.

Dusts are generally considered to be solid particles which have been generated by handling, crushing, or grinding organic or inorganic materials such as rocks, metal, ore, or wood. Dust exists as solid particles ranging in size from 0.1 to 25 micrometers (μ) in diameter. One micrometer is equal to one millionth of a meter. Those particles larger than five micrometers generally settle out of the air before presenting an inhalation hazard. It is important to realize that the dust which will actually enter the lungs and possibly become harmful is too small in diameter to be seen by the human eye.

Some dusts are considered inert or ordinary. This simply means that the dust that enters the lung has not been found to cause physical impairment, disease, or fibrosis (a scarring of the lung tissue) and that it does not destroy the lung's defense mechanism. (However, the presence of this dust may cause the lung's defense mechanism to be activated.) For example, inert iron dust that is inhaled is deposited in the lungs, but this dust inhalation has not been shown to produce a physical impairment, disease, or fibrosis.

Free crystalline silica, sometimes referred to simply as silica, is a dust which has the ability to cause a disease called silicosis. Silicosis impairs the lung's ability to provide oxygen to the body.

Silica is found in two forms: crystalline as in quartz, or amorphous as in opal. Silica and silicates are found throughout the earth in rocks, sands, clays, and the soil. The form of silica with the potential for causing a health problem is the free crystalline form.

The crystal structure of silica is an important factor in the development of the disease silicosis. Another factor in the development of silicosis is the size of the crystalline silica inhaled through the nose and deep into the lungs. It appears that the particle size range of greatest concern is 0.1 to 1.0 micrometer in diameter. This size cannot be detected by the human eye.

The free crystalline silica in this size range, when inhaled over several years, causes the development of silicosis. Some major symptoms of silicosis are shortness of breath, rapid breathing, and an inability of the lungs to furnish enough oxygen to the tissues. The phenomenon that actually takes place in the lung as the disease develops is fibrosis. The silica reacts with the elastic lung tissue causing a scarring (or fibrosis) to occur. This scarring eliminates the elastic property of the lung and does not allow the lung to expand sufficiently to furnish adequate oxygen to the blood stream. An additional concern associated with silicosis is that tuberculosis is often considered as a possible complication.

Some occupations where silicosis has a potential for occurring are foundry work, sandblasting, and mining.

Asbestos is a mineral called magnesium silicate. It is mined from two varieties of rock: serpentine and amphibole. Some of the largest asbestos mines are found in Canada. As a rock, asbestos does not pose a health threat, but as the rock is milled, the fibers break loose and separate. This processing allows the fibers to become thin and short enough to be inhaled. The diameter of the fibers, more than their length, determines which fibers penetrate the lung.

Asbestos has been used widely in manufacturing, construction, and the maritime industry as a product with good heat-stopping and fire-stopping ability. At one time asbestos was used as insulation and to help prevent the spread of fire in warships. It is found in small quantities in the air of almost all major U.S. cities. However, it has two severe drawbacks. Asbestos can cause fibrosis of the lung tissue, and it contributes to lung cancer development, particularly when the exposed individual smokes cigarettes.

Mesothelioma is the rare cancer associated with asbestos inhalation. It is not actually a cancer of the lung, but is a cancer of the lining of the lungs and the pulmonary cavity, which houses the lung. This type of cancer can also occur in the abdominal cavity. Again, it must be remembered that people who smoke and work around airborne asbestos have a much greater incidence of cancer than those who do not smoke and have been exposed to airborne asbestos fibers.

Asbestosis is the name given to the disease that has symptoms associated to over-exposure to asbestos. The fiber length of most concern is 20 to 50 micrometers when the fiber diameter is less than three micrometers. These fine asbestos fibers pass through the upper respiratory tract and come to rest in the lower sections of the lung, where they cause fibrosis. It usually takes anywhere from 10 to 20 years for the disease to develop. As the lung's defense mechanism that coats or attempts to coat the fibers continues to work, the longer fibers produce fibrosis of the lung tissue. The fibrosis prevents the normal transfer of oxygen through the lung to the blood vessels, resulting in reduced ability of the individual to function.

Fibrous glass, because of its similarity to asbestos fibers in size and shape, has been studied to determine if it, too, causes fibrosis of the lungs or mesothelial tumors. Fiberglass has been in use in commercial quantities since the 1940s. Studies in the mid-sixties indicated no abnormal alteration to the lungs of people exposed to fibrous glass during their working career. Other more recent epidemiologic studies have also shown no excess cancer such as mesothelioma or pulmonary fibrosis in workers exposed to fibrous glass during their working lifetime. The only fibrosis or cancer produced has been in studies where large numbers of fibers have been implanted in experimental animals.

ACTIVITY 6:

List two health hazard agents and give an example of a disease associated with each hazard.

1. ______________________________

2. ______________________________

OBJECTIVE 7: Outline two different ways of classifying respiratory irritants.

Respiratory irritants are in a physiological classification of substances and chemicals that, when inhaled, cause inflammation of the mucous membranes in the respiratory tract. This irritation is not the same as chemical corrosion. It is the body's physiological reaction to the inflammation of the tissues that causes the irritation. This reaction occurs at concentrations far below that required to produce chemical corrosion.

Irritants are divided into primary and secondary irritants. Primary irritants are generally considered to produce no systemic toxic reactions. In other words, this type of irritant does not produce a reaction of the body systems such as the liver, blood, or kidney. Its effect is primarily on the mucous membranes of the respiratory tract. Secondary irritants, in addition to producing irritant action on the mucous membrane, also more severely impact other body systems. Chemical pneumonia or absorption of chemicals into the bloodstream are examples of irritants that produce secondary effects on the body.

Another method of classifying respiratory irritants is by the location of the irritated area in the respiratory tract. The divisions are the upper respiratory tract irritants and lower respiratory tract irritants. Additionally, some respiratory irritants affect the complete respiratory tract.

The primary characteristic of upper respiratory tract irritants is that they are soluble in water. This causes the irritant to react with the mucous membranes of the nose and bronchi before entering deeper into the lung. These irritants sometimes cause the bronchi to completely close due to spasms that occur when the individual cannot escape from an over-exposure that affects the upper respiratory tract. The irritant does not enter the lung because the reaction is so pronounced the individual leaves the area for fresh air. An example of an upper respiratory irritant is ammonia.

Lower respiratory tract irritants react deep in the lung. Sometimes this occurs because the chemical is not immediately irritating but subsequently causes severe irritation deep in the lung. These chemicals are not as soluble as primary irritating chemicals. An example of a lower respiratory tract irritant is phosgene, which has a low water solubility. Because of the delayed warning characteristics of lower respiratory tract irritants, they are usually more hazardous to work with than are upper respiratory tract irritants.

Respiratory tract irritants that affect the complete respiratory tract are generally inorganic irritants that are intermediate in water solubility. They may or may not demonstrate warning properties. The halogens such as chlorine, bromine, or iodine are the principle gases in this category.

ACTIVITY 7:

1. In general, lower respiratory tract irritants are more hazardous to work with than upper respiratory tract irritants. (Circle one.) TRUE FALSE
2. Which type of irritant produces effects on body systems other than the mucous membranes of the respiratory tract? (Circle one.)
   PRIMARY IRRITANTS SECONDARY IRRITANTS
3. Give an example of each type of irritant.
   a. Upper respiratory tract irritant ______________
   ____
   b. Lower respiratory tract irritant ______________
   ____
   c. Complete respiratory tract irritant ______________
   ____

OBJECTIVE 8: Briefly explain asphyxiants, anesthetics, systemic poisons, and agents of dermatitis.

ASPHYXIANTS

Asphyxiants affect the body by depriving the individual body cells of oxygen. Oxygen deprivation may result from drowning, from lack of oxygen transport, from chemical interference, or from oxygen dilution. Materials classified as asphyxiants generally do not damage the lung.

Simple asphyxiants are those gases or vapors that act on the body by excluding an adequate supply of oxygen. Examples of simple asphyxiants are helium, nitrogen, and methane. These gases simply replace the oxygen in the air, so that in a confined space the individual would breathe the gas rather than the oxygen. After a person is deprived of oxygen for five to eight minutes, the brain is damaged and then death results.

Carbon dioxide acts as a simple asphyxiant, but it is also active in the body in determining the breathing rate. As the amount of carbon dioxide in the air increases, the individual breathes more deeply and more rapidly. This causes the cycle to increase at a faster rate, eventually ending in death. The percentage of oxygen in the air is not what prevents asphyxiation; rather, it is the partial pressure of the oxygen in the air. If a person lives in Houston, Texas, (at sea level) and travels to Denver, Colorado, (in the mountains), that person becomes short-winded when exercising. The percent of oxygen is the same in both cities, but the partial pressure of the oxygen is reduced in the mountains. In other words, you have the same percent (21%) but of a lesser amount of available air. The shortness of breath is a reaction to the reduced amount of oxygen available to the tissues.

Asphyxiation can also occur due to intoxication by a gas. Intoxication prevents the body from utilizing available oxygen. This is called chemical asphyxiation. In many cases, chemical asphyxiants harm the body at lower concentrations than are needed for simple asphyxiants. The classic example of a chemical asphyxiant is carbon monoxide (CO) generated from incomplete combustion, such as occurs in exhaust systems in automobiles (see Figure 6) or portable gas-filled heaters in homes. Improperly maintained burners and flues also produce carbon monoxide. The carbon monoxide interferes with the transport of oxygen to the cells throughout the body. Since it has an affinity for the hemoglobin in the blood that provides the sites for oxygen transfer, carbon monoxide robs the oxygen of the mechanism needed to reach

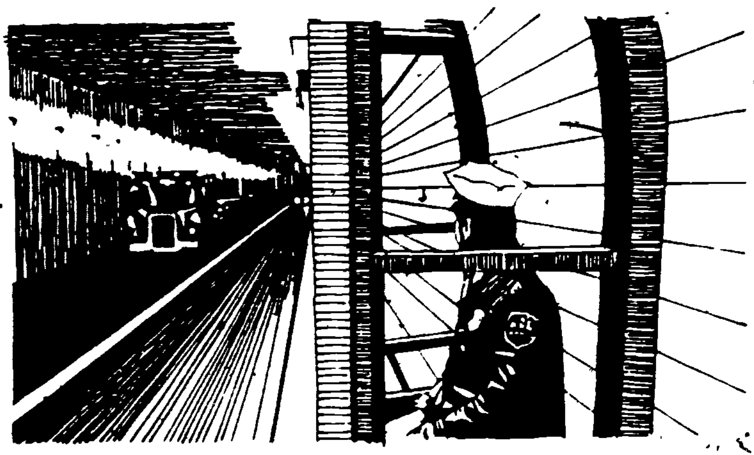

Figure 6. Work environments in which CO exhaust is present in an enclosed area are particularly dangerous.

the cells. At its worst, carbon monoxide causes death, but lower levels of exposure can affect the person's mental and physical ability to function. Common symptoms of overexposure include pounding of the heart, a dull headache, flashes before the eyes, dizziness, ringing in the ears and nausea. Drowsiness while driving can be caused by a low level exposure to carbon monoxide. Carbon monoxide is odorless and colorless and cannot be detected by the senses.

ANESTHETICS

Anesthetics have presented a problem to workers not only on the job but off the job as well. An anesthetic is a depressant. It affects the central nervous system and the brain, and thus reduces the ability of the individual to think and react to changing situations. A classic example of off-the-job exposure to an anesthetic is through intake of excessive amounts of alcohol. Concern has also been expressed for doctors and nurses who work in hospital operating rooms where anesthetics are used regularly.

POISONS

Systemic poisons (poisons affecting the body systems) that enter the body can affect the central nervous system, the kidneys, liver, blood, lungs, and other organs of the body. Chemicals that produce liver damage are called heptotoxic agents. Examples of substances or chemicals that affect the liver are carbon tetrachloride, tetrachloroethane, nitrosamines, and components of certain types of mushrooms.

Chemicals or materials that demonstrate their toxic symptoms on the nervous systems are called neurotoxic agents. The manner in which the nervous system is affected depends upon the substance acting on the system. Organometallic compounds are particularly dangerous to the central nervous system. Neurological damage may result from methylmercury or tetraethyl lead in high concentrations. The classic example of this type of exposure is the Mad Hatter in Alice in Wonderland. His odd actions have been attributed to the practice of using mercury in the manufacture of felt hats, hence, the "Mad Hatter."

Kidney damage is caused by nephrotoxic agents. Chemicals called halogenated hydrocarbons as well as uranium have been linked to kidney damage. Heavy metals can also cause kidney damage.

The blood system, which acts as the carrier for oxygen and nourishment for the cells, is also subject to damage. Another name for the blood system is the hematopoietic system. It can be damaged by metals such as arsenic and lead as well as certain chemicals such as benzene.

DERMATITIS

In an earlier objective, skin absorption was discussed as a route of entry into the body. The skin can be irritated without the chemical actually penetrating the skin. It may be irritated by temperature, sunlight, vibration, and friction as well as chemicals.

When the skin is irritated, the resulting condition is called dermatitis. The agent may be a chemical, a mechanical movement, a physical abuse, a plant poison, or a biological exposure. The most common cause of dermatitis is the chemical agent, which acts as a primary irritant or as a sensitizer.

A primary irritant acts at the time of exposure and causes a reaction such as a rash, a blister, or a burn. Some chemicals affect the skin by removing its natural oils. This causes the skin to dry and crack. Other chemicals work to thicken the outer layer of skin or cause chemical reactions that irritate the skin.

ACTIVITY 8:

1. Name one of the ways asphyxiants can deprive the cells of oxygen. ____________________

2. Match the systemic poison with the system which it affects.

_____ benzene		a.	nervous system
_____ nitrosamines		b.	kidney
_____ halogenated hydrocarbons		c.	blood system
_____ mercury		d.	liver

OBJECTIVE 9: Cite five types of physical health hazards.

The physical health hazards to be considered are: electromagnetic and ionizing radiation, noise, vibration, temperature, and pressure.

RADIATION (IONIZING AND NONIONIZING)

Ionizing radiation hazards have demonstrated a physiological effect of heating the tissues of individuals exposed to microwave and radio frequency radiation. Based upon some studies, other hazards ranging from decreased sexual ability to emotional instability may also be associated with these exposures. This is a relatively new area of investigation, and conclusive data that shows behavioral effects associated with these exposures is not complete.

Ionizing radiation as a hazard is well documented. Ionizing radiation, from x-rays to the effects of nuclear reactions in power production, are a part many job tasks. When sources of radiation are handled improperly, severe consequences can occur. Some of the consequences are dermatitis, leukemia, cataracts, sterility, and the shortening of life.

NOISE

Noise causes hearing loss when it reaches or exceeds specified levels (90 dBA [decibels on the A scale] over an average eight-hour day is considered harmful). The hearing loss is usually gradual and nonreversible. For this reason, the individual does not realize that noise-induced hearing loss is happening until it is too late. An audiometric test taken periodically will help to identify a trend that might indicate a hearing loss. One of the methods used to screen noise-induced hearing loss is to look for a loss at the 4,000-Hertz frequency, because the loss usually shows up at this frequency before other frequencies are affected.

VIBRATION

Vibration from equipment such as a jack hammer can cause a disease called "white fingers." This disease is characterized by numbness of the fingers, reduction of sensitivity to temperature extremes and pain, and loss of muscular control. Vibration exposure is not limited to the extremities alone. Whole body vibration or vibration that affects the head, chest, or abdominal cavities can cause discomfort. Some studies of the effects of vibrations on humans have shown inability to maintain a steady posture, nausea, weight loss, decreased visual activity, and insomnia. Vibration may affect truck drivers, operators of heavy equipment, railroad workers, machine operators, loggers, and pneumatic tool operators.

TEMPERATURE EXTREMES

Temperature extremes affect the body's metabolism and ability to perform tasks. In hot environments, acclimatization is essential to task performance. Prolonged exposure to hot environments may cause decreased morale, increased anxiety, and irritability, as well as loss of concentration ability. Physical disabilities range from heat rash to heat stroke. In cold environments the main concern is conservation of body heat. Frostbite is also a major concern in cold environments because it may not be noticed early enough to prevent tissue damage and possible loss of extremities. As the wind increases, the chill factor becomes important because it drives the skin temperature down lower than a thermometer reading would indicate. Hypothermia occurs when the body loses more heat than it produces, resulting in exhaustion and death if cooling continues. Sedatives and alcohol only serve to increase the danger.

THE HAZARDS OF HIGH PRESSURE WORK ENVIRONMENTS

Work in high air pressure has been done for many years. In early civilizations divers were among the first to experience high pressure work environments and they continue to do so today. Crews constructing tunnels also work under high air pressure. A more recent development in high air pressure work environments is the provision of hyperbaric medical facilities, in which surgeons operate under conditions of high pressure.

The earlier diver, sometimes referred to as a free diver, experienced a force or squeeze of the water on his body similar to the squeeze felt by a person who dives to the bottom of a swimming pool. The greater the depth, the greater the squeeze, and the greater the chance of drowning. As the technology of diving became more sophisticated with the use of hard hat diving suits and later, of self-contained breathing apparatus (scuba), the diver had to begin to contend with greater pressure changes and a problem referred to as the bends. The bends are caused from nitrogen bubbles forming in the bloodstream after too rapid an ascent or decompression. Once this happens, the diver must be repressurized according to procedures developed over the years. Other problems occur under pressure changes: cavities in teeth and middle ear pressure can be the cause of intense pain for divers. Nitrogen narcosis, sometimes called rapture of the deep, causes the diver to have a feeling of euphoria and lose the ability to concentrate.

Caisson and tunnel workers, who work under pressures of up to four atmospheres, have problems associated with excessive air pressure. The pressure they work in is used to help support the underground cavity in which the workers function. They, too, can and do experience the bends and may require decompression therapy as part of their daily work routine. Neurologic damage, hearing loss, vertigo, nausea, and visual problems are other examples of symptoms associated with exposure to high air pressure.

ACTIVITY 9:

List five types of physical health hazards, and define three of them.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

OBJECTIVE 10: Identify health hazards associated with different types of radiation.

Two basic types of radiation will be discussed: ionizing and nonionizing. In the category of ionizing radiation, alpha, beta, x-ray, and gamma radiation are of concern. Two nonionizing types of radiation that may be encountered in the workplace and that will be discussed are infrared and ultraviolet radiation.

Radiation from ultraviolet and infrared sources are considered agents of health hazards. Ultraviolet rays are those wavelengths of the electromagnetic spectrum which are shorter than those of visible light and longer than x-rays. Infrared rays are those wavelengths of the electromagnetic spectrum which are longer than those of visible light and shorter than radio waves. The spectrum is depicted in an abbreviated form in Figure 7.

COSMIC RAYS	X-RAY	ULTRAVIOLET	VISIBLE	INFRARED	RADIO	ELECTRIC POWER LINE

SHORT WAVELENGTH ... LONG WAVELENGTH

Figure 7. Electromagnetic spectrum.

Ultraviolet light, depending upon its wavelength, causes pigmentation, and the shorter ultraviolet wavelength causes heat. These combined effects are noticed when a person is overexposed to the sunlight when attempting to get a suntan, and receives a sunburn instead. It can also produce a "sand-in-the-eye" effect and inflame the cornea of the eye. It can injure the eye without warning and only after a period of several hours does the irritation become noticeable. One other hazard associated with ultraviolet radiation is that many photosensitizing agents act in this wavelength causing a reddening of the skin upon exposure to some chemicals and the sun. Ultraviolet light also has useful qualities and has been used for germicidal control in hospitals and for treatment of certain diseases.

Infrared radiation usually shows its effect immediately by causing a burning sensation upon exposure. In the industrial setting, infrared radiation often occurs as a heat wave coming from a hot body such as a furnace. It is dangerous to the eye because the eye does not sense the heat as does the skin. Cataracts, which are an opacity of the back surface of the lens of the eye, are one possible result of infrared radiation and have been reported in the glass-blowing industry. The heat lamp is an example of infrared radiation use in everyday life.

Two examples of ionizing radiation are radium and x-rays. These two health hazard agents illustrate the difference between internal and external hazards very well. An internal hazard comes from a radiation source which emits alpha waves. The alpha waves do not have the ability to penetrate the skin but once an alpha source is ingested, inhaled, or gains entry through a break in the skin, it can be deadly to the cells. (Beta and gamma rays can also be deadly to cells.) The x-ray illustrates an external hazard because it can penetrate the skin, and in high levels can damage tissues and cells within the body. Both types of ionizing radiation damage cells.

Radium is a classic example of a radioactive source that emits alpha waves as well as the more penetrating gamma waves. As mentioned above, alpha waves cannot penetrate the intact skin, but if the skin is cut or if radium is ingested, it can cause severe damage from the alpha waves it emits; hence, the term "internal hazard." One of the best documented examples of radium exposure is from radium dial painters who painted the luminous numbers on watch dials. The exposure occurred when the workers, as a matter of practice, placed their brush to their tongues in an attempt to get a better point for painting. The exposure of the dial painters was found to cause bone cancer.

The term "x-ray" is used daily, and since it is used by physicians in diagnosing diseases, it is considered useful. It is also used at much higher intensity to check welds in steel fabrication. At higher intensity, x-rays can be dangerous if not handled properly, that is, used with appropriate shielding and personal protective equipment. A danger also exists from the familiar x-ray if proper controls are not maintained to protect the patient. X-rays are similar to gamma radiation in that they readily penetrate the body, and only adequate mass such as in lead shields will halt penetration.

ACTIVITY 10:

(Fill in the blanks.)

1. Infrared radiation is associated with ________
2. Exposure to radium has been known to cause ________
____
3. ________ are used at high intensity to check welds in steel fabrication, and this can be dangerous unless appropriate ________ and personal protective equipment are used.

OBJECTIVE 11: Identify four biological health hazards.

Biological hazards include insects, molds, fungi, viruses, parasites, and bacteria. The presence of insects such as flies and roaches is an indication of an overall lack of cleanliness and sanitation practices. Flies carry infection and disease to people readily. They are best controlled by eliminating their breeding grounds and reducing their food supply through close attention to a clean environment. Roaches are more prevalent than flies but do not have the history of carrying disease and infection. Roaches can be controlled in the same manner as flies.

Fungi and fungal diseases usually affect farmers and others who work outdoors. Fungal diseases in industry are not considered a major problem. However, there are a large number of fungi available. They usually affect someone with breaks in the skin, or someone hypersensitive to a specific fungus. Fungal diseases may also affect body systems.

Bacterial infections usually occur in a minor wound where the skin is broken. One of the important factors to prevent bacterial infection is good personal hygiene. A well-known example of a bacterial infection is tetanus (lockjaw), which can occur when the skin is cut. If tetanus is left untreated, it causes spasms of the neck and back with a high mortality rate.

The following chart (Table 1) identifies several biological health hazards. This list represents several bacterial infections, viral diseases, fungal diseases, and parasitic diseases. Many parasitic diseases are zoonotic. Zoonoses are diseases that are transmissible between animals and humans.

TABLE 1. REPRESENTATIVE EXAMPLES OF BIOLOGICAL HEALTH HAZARDS.

Disease	Route or Entry	Effect	Prevention
Tetanus/Lockjaw	Break in the skin	Spasms in neck and back muscles; 70% mortality	Immunization
Anthrax	Breaks in the skin or inhaled spores	Respiratory infection, fever, shock, death	Proper disinfection of hides and immunization and personal hygiene
Brucellosis	Cuts and scratches contaminated with fluids from infected animals	Flu symptoms, weight loss, weakness	Control the disease in animals, good personal hygiene and prompt treatment of cuts
Leptospirosis	Breaks and cuts in the skin contaminated by infected animal urine	Fever, headache, chills, jaundice, hermorrhage; 20% mortality	Boots and gloves for workers around infected animals; rodent control and proper waste disposal
Plague	Bit of an infected flea (bacterium with Pasteurella pestis)	Lymph node pain and inflammation; high mortality	Control of rats and immunization
Tuberculosis/TB	Inhalation of the bacteria	Fever, emaciation	Isolation of those infected; medical surveillance
Food Poisoning	Oral	Fever, abdominal colic, nausea; recovery usually in 24 hours	Personal hygiene, proper food handling and antibiotic therapy
Rabies	Usually infected animal bites	Fatal, acute encephalitis	Avoidance of infected animals and bats; immunization
Histoplasmosis	Inhalation or mouth lesions from areas where the fungus grows on soil enriched by bat, chicken, and other bird excrements	Similar to TB, may be a self-limiting infection to fever, emaciation, and death, depending on the victim	Control of dusts the fungus grows in; spraying soil with disinfectant
Ring worm	Contact with person or animal infected with this type fungi	Lesion of the skin in spreading ring shape	General and personal hygiene, avoidance of infected animals or persons
Hookworm	Larva invade exposed skin	Iron deficiency anemia due to blood loss caused by the parasites	Proper disposal of human waste and wearing of of shoes

ACTIVITY 11:

Name four biological health hazards.

1. ____________________

2. ____________________

3. ____________________

4. ____________________

OBJECTIVE 12: Describe three ergonomic health hazards.

Ergonomics is the science of designing workplaces where workers can be as comfortable and as efficient as possible while they do their jobs. To do this, engineers have to gather information about how the human body and mind work, and use this to design the best job situation. Ergonomics experts are even concerned with the air one breathes on the job - its temperature, humidity, and cleanness. The effect of noise, vibration, and speed are studied, as well as the way people work with machines. Three items describe the purpose of ergonomics.

- Designing something (such as a piece of equipment or a chair) specifically for the people who will use it.
- Simplifying a system so that as few human errors as possible will be made.
- Designing the system to fit the needs and limits of human beings instead of trying to fit people into a system that is already built.

One of the results of poor design of equipment or of a process is worker fatigue. Fatigue is a feeling of being tired; therefore, rest or a change in activity should allow the individual to recover. Repetitive motion and monotony are two of the primary factors in producing fatigue. If it continues on a daily basis, fatigue becomes a chronic or long-term problem with psychological effects, nonspecific physical complaints, and absence from work. By providing rest or change in activity, as well as a properly designed work environment, fatigue and other effects of monotonous, repetitive motion can be reduced.

Although monotony, repetitive motion, and fatigue are many times interrelated, each may pose a hazard in itself. Monotony affects individuals to the point where they may react slowly to an approaching hazard. The classic example of this condition is a vehicle driver who drives continuously for a long period of time and does not react properly to an oncoming auto, or simply drives off the road as it makes a curve.

Repetitive motion tasks are sometimes necessary in the industrial setting. (See Figure 8.) These tasks should be designed to allow as much postural freedom as possible. If the task can be designed so that the operator may work equally well while sitting or standing, it will be beneficial to both the operator and to production. Failure to compensate for repetitive motion will result in fatigue of the workers and lower efficiency.

Fatigue may occur from a combination of monotony and repetitive motion or from other factors. Excessive heat or cold may cause the onset of fatigue. When a worker repeatedly lifts an object which is too heavy, fatigue occurs. Fatigue may also be induced when the worker must extend a part of

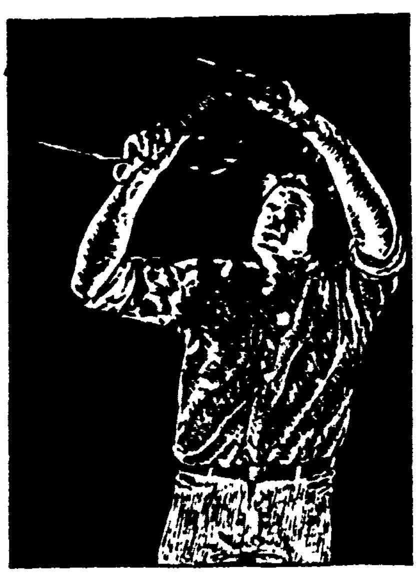

Figure 8. Some tasks require repetitive motion.

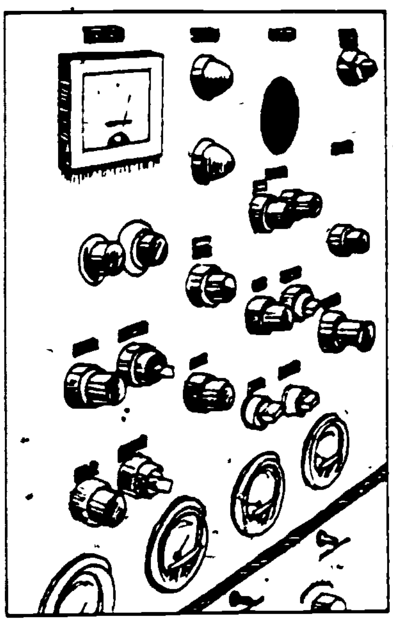

Figure 9. Excessive number of dials may cause fatigue, unless they are grouped and marked properly.

the body for greater than normal distances to accomplish a task. Trying to read an excessive number of dials (Figure 9) or to process an excessive amount of data not only causes fatigue but may also contribute to catastrophes or near catastrophes. Aircraft pilots have a large number of dials and gages to read, and they must then process the data to successfully fly the plane. However, due to proper grouping of the dials and gages, pilots are able to adequately process the necessary data to fly the plane safely.

ACTIVITY 12:

Name three ergonomic health hazards.

1. ________________________________
2. ________________________________
3. ________________________________

OBJECTIVE 13: List the personal and mechanical protective mechanisms used to avoid health hazards.

Protective mechanisms fall into the two general categories of personal and mechanical (engineering). Mechanical or engineering controls are considered more desirable, but personal protective controls are necessary for some situations.

Personal protective devices are items such as respirators, safety shoes, hard hats, safety glasses, and personal protective clothing and gloves. Each item is designed to protect against a specific type of hazard, or to protect a specific part of the body. However, protective equipment is designed for a specific task, and may not be interchangeable with other similar items. An example of this would be gloves, which may protect against one solvent but not another, or respirators which have specific capabilities to protect against only certain chemicals.

Personal actions can also protect the worker. Washing your hands in chemicals and splashing chemical in your eyes are two classic examples of things that should not be done. Things that should be done are the following of proper work procedures and the wearing of personal protective equipment.

A formal method of recognizing hazardous personal actions has been developed. It is called Job Safety Analysis (JSA). It is a system where three factors are considered: (1) sequence of basic job steps, (2) potential accidents or hazards, and (3) recommended safe job procedures. Sometimes step three may involve an engineering control such as placing a guard over a moving part, but many times it involves a procedural change requiring personal action. A JSA helps the worker to determine what to do and how to do it to perform an operation safely.

A personal action to prevent illness or injury is to wear proper respiratory protection and to work upwind when opening a tank of toxic chemicals. This is done to prevent inhalation of dangerous vapors. Another procedure involves proper lifting of a heavy object with the legs, not the back. Never standing under a suspended load is another precaution against injury. A requirement to wear eye protection when grinding steel protects the worker's eyes. Other examples of procedures which protect the worker are numerous, and each individual can think of additional ones from everyday life experiences. One procedure that is very basic yet very effective is the use of water as a wetting agent in dust control. When steel plate is being sandblasted, the use of a water spray during the operation effectively controls the level of silica dust so that it remains below dangerous concentrations. Water is used in a similar fashion to control asbestos fibers when insulation is removed from steam lines.

Mechanical and engineering controls are desirable because they do not allow personal error. By placing an individual away from a source of danger, the danger is eliminated because the individual is no longer present. An example of this would be isolating a worker from a noise source by placing the worker in an enclosed quiet booth. The source of danger may also be isolated. This is accomplished by designing a process to be totally enclosed so the workers cannot come in contact with the hazard. This is a system widely practiced in the petrochemical industry.

Specific engineering controls are designed to solve basic health hazards. The most reliable solution to airborne hazards is to incorporate a local exhaust ventilation system to remove the contaminants. This method is used to remove dust from grinding operations, fumes from welding operations, and toxic vapors from any number of situations. The principle involves placing a properly designed hood at the point of evolution of the hazardous contaminants. A ductwork system then carries the contaminant to a cleaning device or scrubber that is away from the worker. When correctly applied, ventilation safely controls the toxic contaminants generated in most manufacturing situations.

Figure 10. A safety shower is designed to wash a chemical off quickly, before it has time to act.

Engineering principles are also used to react to a situation after a hazardous situation has evolved. A sprinkler system designed to control a fire is one example familiar to most people. After a fire begins, the sprinkler system reacts to minimize the loss of life and property. The proper placement and design of eyewash fountains and safety showers help to reduce the suffering of someone who has a caustic or acid in the eyes or on the body. A safty shower is designed to wash a chemcial from a person's body before the chemical can cause harm. (See Figure 10.) Engineering controls begin with the initial design of a facility and continue through its development and operation. Finally, engineering principles are used to devise methods for reacting to hazards once they develop.

ACTIVITY 13:

1. List three personal protective mechanisms.

   a. ______

   b. ______

   c. ______

2. Name two mechanical and two engineering principles used to avoid injury or minimize the effect of a hazard.

   a. ______

   b. ______

   c. ______

   d. ______

OBJECTIVE 14: List ten observable conditions that could indicate the presence of a health hazard on the job.

This module has reviewed the various types of health hazards that may be encountered in the workplace, the way in which workers experience these hazards, and some of the methods that are used to control them. Although no one can become an instant expert on a subject as complex as occupational health, a general awareness of health hazards should help workers to ask the right questions about their jobs. Certain conditions that might indicate the presence of a health hazard can be observed by workers; some of these are listed below. Keep in mind that the presence or absence of any of these conditions does not necessarily mean that there is or is not a hazard. For example, the odor of styrene can be detected at far below hazardous levels, while deadly carbon monoxide cannot be smelled at all. Therefore, an unknown odor is something to be investigated before any conclusions regarding health hazards are drawn.

HEALTH HAZARDS IN THE WORKPLACE - QUESTIONS

1. What odors, if any, can be detected?

2. Are there dust clouds present in the workplace? Has dust accumulated on machinery, workbenches, ledges, or other surfaces? Is there dust on workers' clothing, skin, or hair? Is dust swept, vacuumed, or mopped as part of the regular dust control routine? Is dust sprayed down as a means of controlling it?

3. Upon entering the workplace, do you or others around you suffer sensitive reactions, such as coughing, sneezing, watering eyes, runny nose, irritation in the throat or skin reactions such as rashes, redness, or itching?

4. Are local ventilation systems being used to draw dust or fumes away from worker's breathing zones? (Look for hoods, hoses, or ducts to indicate such systems.)

5. Are workers wearing respirators? If so, what kind? Do respirators appear to be well-fitting?

6. Where solvents are used, how are they handled? Do workers mix or pour chemicals? If so, what kind of protective clothing and equipment (gloves, goggles, face shields, barrier creams) are being worn? Where corrosive chemicals are in use, are eyewash fountains and safety showers available?

7. Are all chemicals clearly labeled with the name of the product, the kind of hazard involved, the seriousness of the hazard, and what to do in emergencies involving the chemical?

8. How are chemicals stored (in what kind of containers and cabinets, and next to what other chemicals)?

9. How [illegible]icals cleaned up when they are spilled? How are chem-[illegible] disposed of when they are no longer needed?

10. Is the workplace free from insects and rodents?

11. Do food handling areas, washrooms, locker rooms, showers, and toilets appear to be clean and sanitary?

12. Do drains and sewer systems appear to function properly?

13. Does the work environment include constant loud noise? Do you have to shout to be heard? Is ear protection worn in noisy areas?

14. What forms of radiation, if any, are present on the job? Have precautions regarding radiation been taken, where needed?

15. Do workers experience extremes of temperature or air pressure on the job?

16. Do work procedures involve repetition or vibration, or require very uncomfortable postures for long periods of time?

17. Are caution and danger signs posted where appropriate?

18. Is smoking allowed near flammable materials? Is food allowed in work areas where toxic chemical or biological hazards may be present?

19. Is the work area generally clean, free from excessive dust, spills or clutter?

20. Where employees work around hazardous materials that could be carried home on clothing or skin, are showers and clean lockers available for use?

21. Are work procedures around hazardous materials carried out properly, without haste or horseplay?

ACTIVITY 14:

1. List five places in the workplace where dust might be found.

   a. ______________________
   b. ______________________
   c. ______________________
   d. ______________________
   e. ______________________

2. List three ways in which dust may be controlled.

   a. ______________________
   b. ______________________
   c. ______________________

3. List three sensitive reactions one could suffer in the workplace that might indicate a possible hazard.

   a. ______________________
   b. ______________________
   c. ______________________

4. List four factors in the safe handling of hazardous chemicals.

   a. ______________________
   b. ______________________
   c. ______________________
   d. ______________________

5. List three physical hazards that may be present in the workplace.

   a. ______________________
   b. ______________________
   c. ______________________

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ANSWERS TO ACTIVITIES

ACTIVITY 1

1. Recognition - c.
2. Evaluation - b.
3. Control - a.

ACTIVITY 2

1. a. chemical.
   b. physical.
   c. biological.
   d. ergonomic.
2. a. air contaminants, skin irritants.
   b. radiation, noise, vibration, temperature, pressure. (Any 2).
   c. insects, molds, fungi, viruses, parasites and bacteria. (Any 2).
   d. poor design of equipment, poor design of work process or operation.

ACTIVITY 3

1. a. inhalation.
   b. skin absorption.
   c. ingestion.
2. a. inhalation.
   b. volume, lung, blood stream.
   c. filter.
   d. gasoline, alcohol.
3. a. True.
   b. False.

ACTIVITY 4

1. a. Threshold Limit Value.
   b. Permissible Exposure Levels.
2. concentration, safe.
3. ~~a.~~ False.
   b. True.
   c. False.

ACTIVITY 5

1. a. liquid. d. fume.
   b. gas. e. mist.
   c. dust. f. vapor.
2. Gas - a state of matter in which the substance has neither a definite volume or shape.

   Vapor - the gaseous form of a substance which is normally in the liquid or solid state and which can be transferred to these states either by increasing the pressure or decreasing the temperature.
3. Dust is composed of solid particles of organic or inorganic materials.

ACTIVITY 6

1. Slicia - silicosis.
2. Asbestos - mesothelioma, asbestosis (any one of the two).

ACTIVITY 7

1. True.
2. Secondary irritants.

3. a. ammonia.

   b. phosgene.

   c. the halogens: chlorine, bromine or iodine. (Any one).

ACTIVITY 8

1. Robbing the oxygen of its means of getting to the cells, replacing the oxygen in the air in a confined space, or increasing the breathing rate. (Any one of the three.)

2. c - benzene.

   d - nitrosamines.

   b - halogenated hydrocarbons.

   a - mercury.

ACTIVITY 9

1. Electromagnetic (nonionizing) and ionizing radiation.
2. Noise: 90 dBA over an eight-hour day.
3. Vibration: vibration from jackhammer and other equipment.
4. Temperature extremes: temperatures that are too hot or too cold.
5. Pressure: diving, tunnel work, hyperbaric units.

ACTIVITY 10

1. Cataracts.
2. Bone cancer.
3. X-rays, shielding.

ACTIVITY 11

(Any four.)

1. Insects.
2. Molds.
3. Fungi.
4. Bacteria.
5. Viruses.
6. Parasites.

ACTIVITY 12

1. Fatigue.
2. Monotony.
3. Repetitive motion.
4. Stress.

ACTIVITY 13

1. a. Personal protective devices.
   b. Personal actions.
   c. Engineering controls.
2. a. (structural) guards.
   b. isolation.
   c. exhaust ventilation systems.
   d. sprinkler system.
   e. proper placement and design of safety showers and eyewash fountains.

ACTIVITY 14

1. (Any five.)
   a. Machinery.
   b. Workbenches.
   c. Ledges.
   d. Worker's clothing.
   e. Skin.
   f. Hair.
2. (Any three.)
   a. Sweeping.
   b. Vacuuming.
   c. Mopping.
   d. Ventilation systems.
3. (Any three.)
   a. Coughing.
   b. Sneezing.
   c. Watering eyes.
   d. Runny nose.
   e. Irritation in the throat.
   f. Rashes.
   g. Redness.
   h. Itching.

4. (Any four.)

   a. Protective clothing and equipment.

   b. Provision of eyewash fountains and safety showers.

   c. Clear labels.

   d. Correct storage.

   e. Safety disposal.

   f. Good cleanup procedures.

5. (Any three.)

   a. Constant loud noise.

   b. Radiation.

   c. Extremes of temperature.

   d. Extremes of pressure.

   e. Vibration.